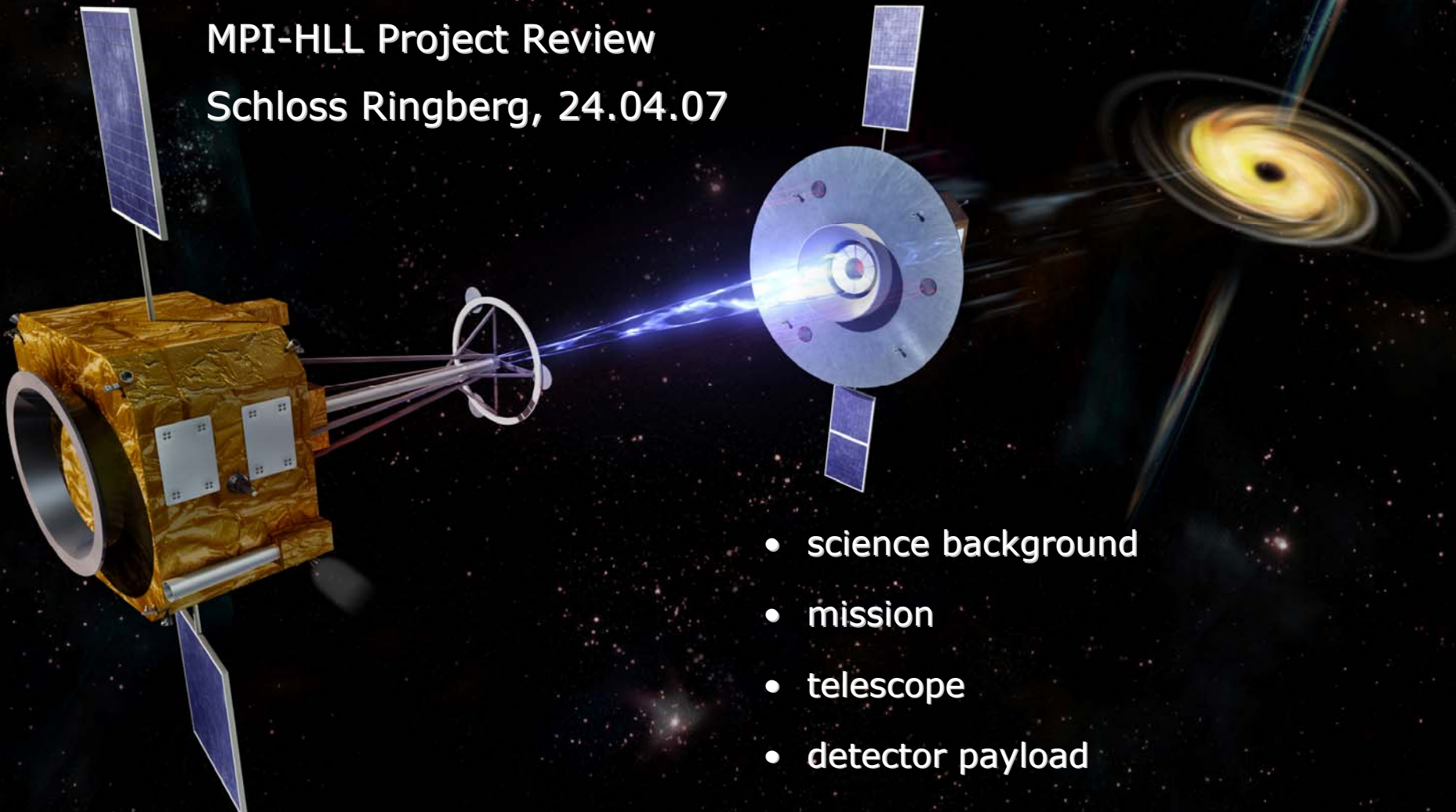


# SIMBOL-X

**Peter Lechner**

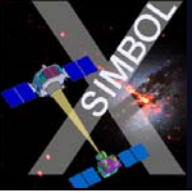
MPI-HLL Project Review

Schloss Ringberg, 24.04.07



- science background
- mission
- telescope
- detector payload
- low energy detector





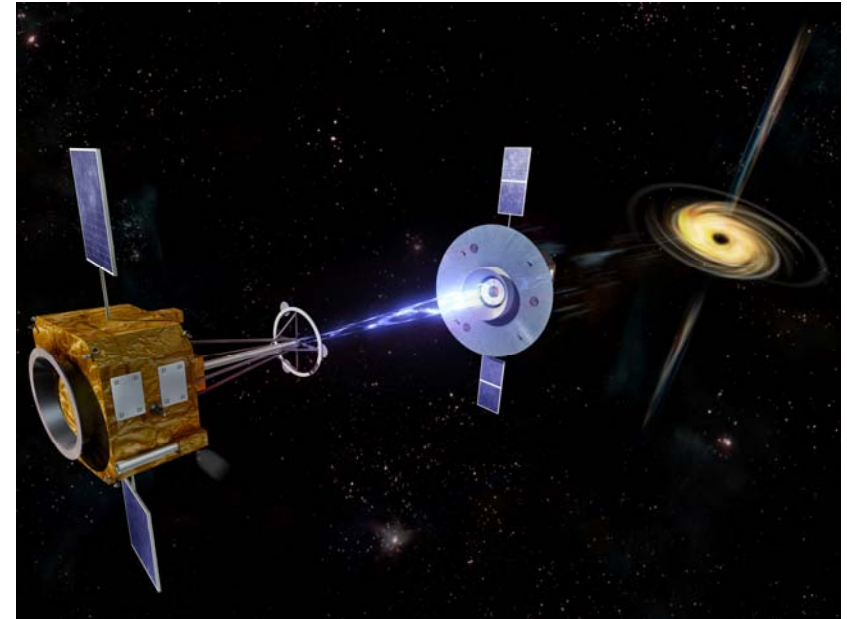
# mission

## ■ mission scenario

- ▷ detector and mirror spacecraft
- ▷ 4 days orbit (20.000 / 180.000 km)
- ▷ > 70 % observation time
- ▷ time budget
  - 0.5 y commissioning
  - 2.5 y nominal operational phase
  - 2 y extension provision
- ▷ net science time: > 100 Msec
- ▷ no. of pointings: ~ 1000 (+ 500)
- ▷ on-board data storage
- ▷ telemetry 1x / orbit

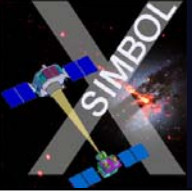
## ■ status

- ▷ French-Italian-German consortium
- ▷ phase A (F, D → Jun07, I → Nov07)
- ▷ phase B likely to come in 2008
- ▷ launch end 2013 (Soyuz/Kourou)



## ■ formation flight

- ▷ probably 1st science mission
- ▷ autonomous operation
- ▷ alignment by radio antennas and laser system
- ▷ positioning accuracy:  $1 \times 1 \times 3 \text{ cm}^3$
- ▷ positioning knowledge:  $0.5 \times 0.5 \text{ cm}^2$



# telescope

## ■ leadership

- ▷ Osservatorio Astronomico di Brera, Italy
- ▷ industry contract: Alenia

## ■ principle

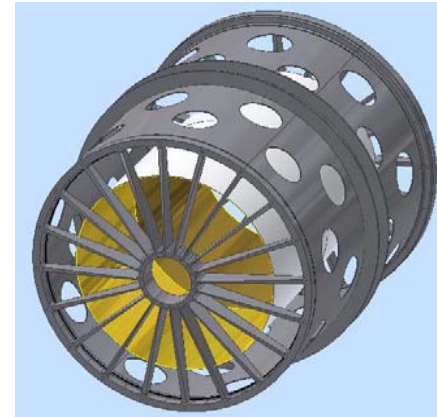
- ▷ nested mirrors, Wolter-I geometry

## ■ technique

- ▷ Ni electroforming replication
- ▷ Pt/C multi-layer coating by sputtering
- ▷ 2 spider support structures

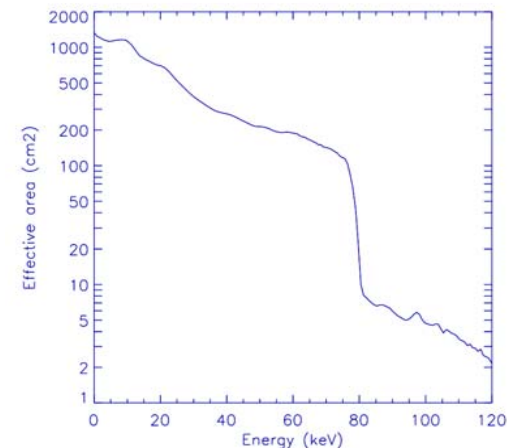
## ■ parameters

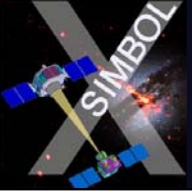
- ▷ no. of shells      ~ 100
- ▷ focal length       20 m
- ▷ diameter           ~ 70 cm
- ▷ shell tickness     1/3 of XMM



## ■ effective area (on axis)

- ▷ > 1000 cm<sup>2</sup> @ 2 keV
- ▷ > 600 cm<sup>2</sup> @ 8 keV
- ▷ > 100 cm<sup>2</sup> @ 70 keV

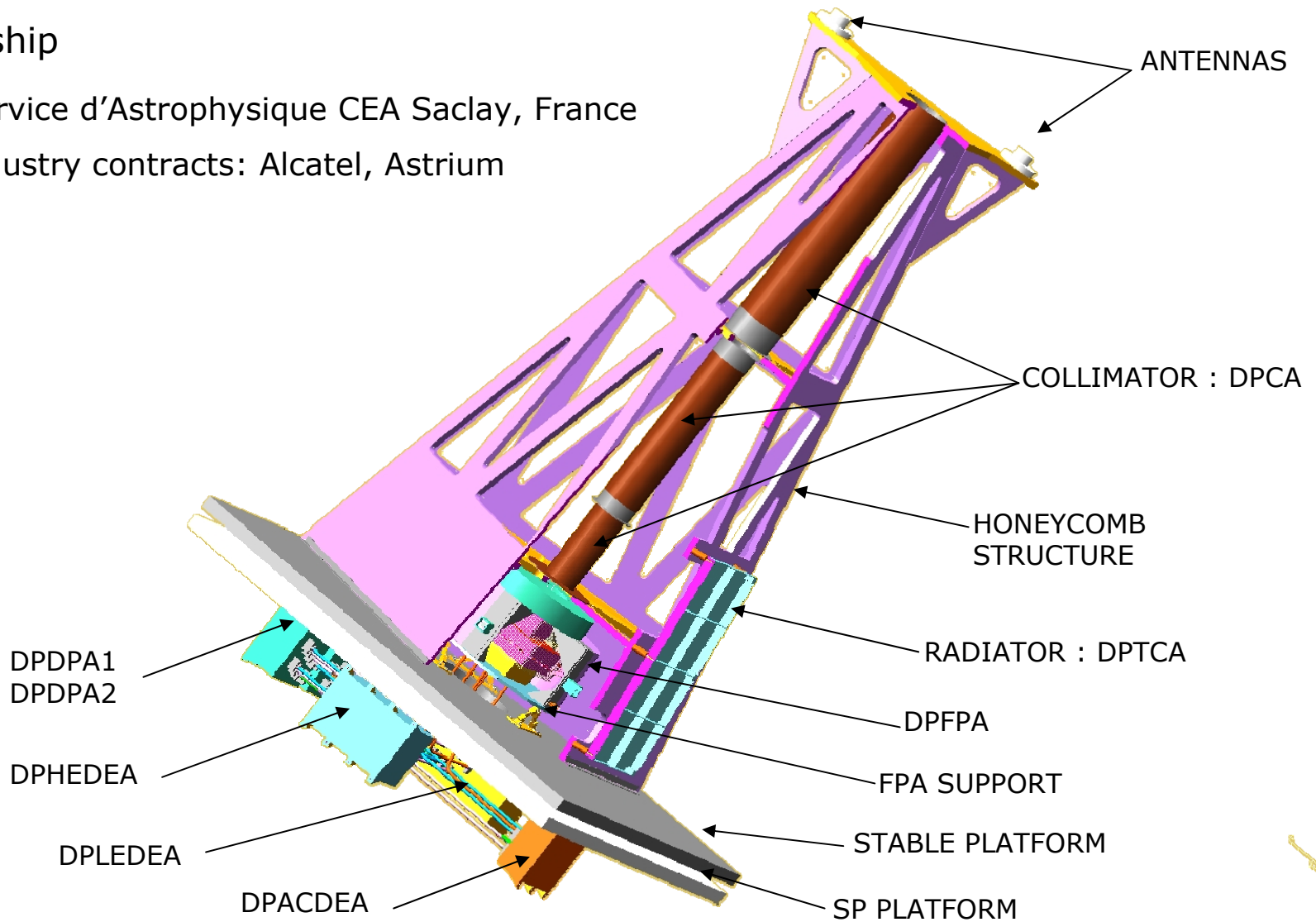


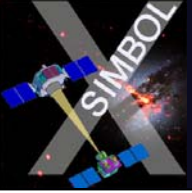


# detector payload

## ■ leadership

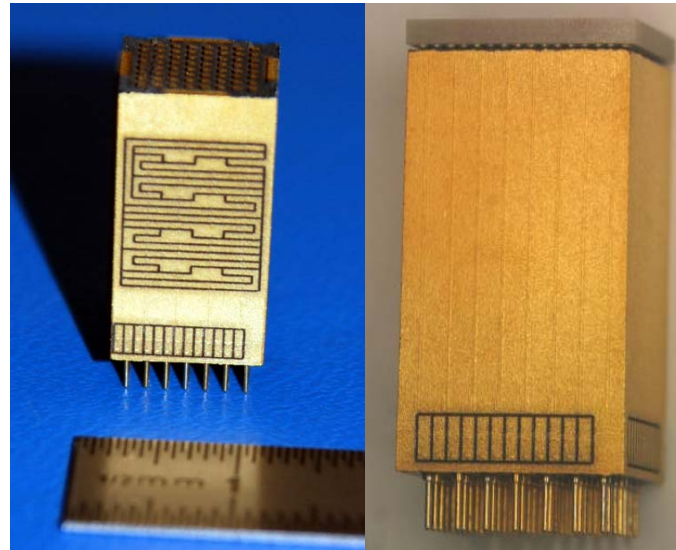
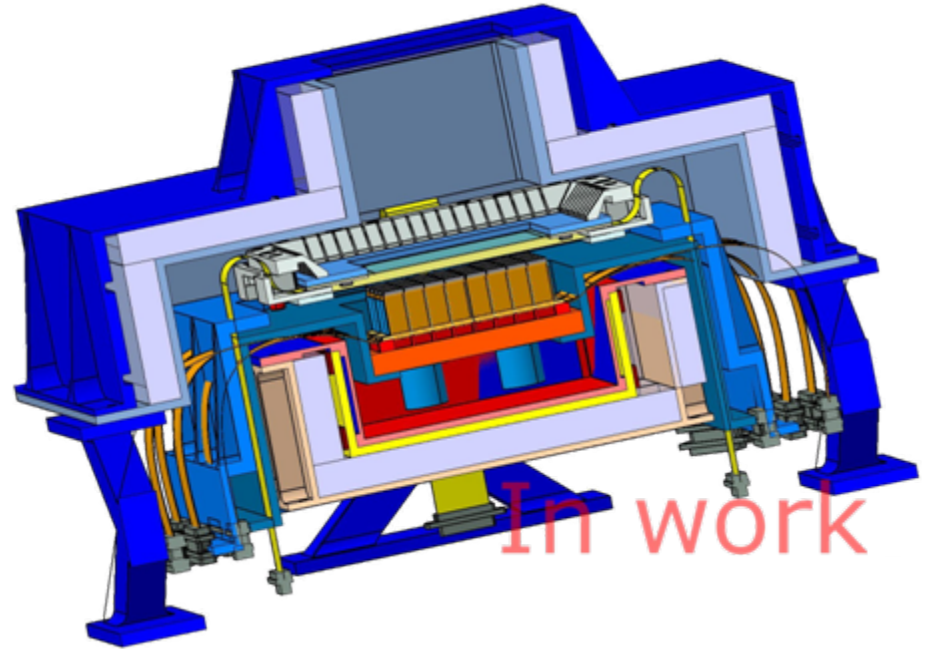
- ▷ Service d'Astrophysique CEA Saclay, France
- ▷ industry contracts: Alcatel, Astrium





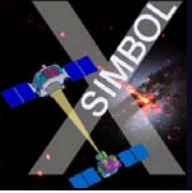
# detector payload

- low energy detector (LED)
  - ▷ energy range 0.5 ... 20 keV
- high energy detector (HED)
  - ▷ energy range 5 keV ...
  - ▷ CdTe / CdZnTe (both under test)
  - ▷ pixel size 625 x 625  $\mu\text{m}$
  - ▷ focal plane format 128 x 128
  - ▷ sub-units of 16 x 16
  - ▷ 3D integration of fe-electronics
  - ▷ status: working 8 x 8 module
- active anti-coincidence shield
  - ▷ plastic scintillator
  - ▷ PMT readout
  - ▷ fibre coupling
  - ▷ status: material selection



"Calliste64"  
HED subunit

- Calliste256
- 1  $\text{cm}^2$
  - 4 side buttable
  - 4 r/o ASICs
  - self-triggered
  - 64 x in FP



# LED requirements

## ■ science drivers

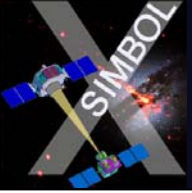
- ▷ cosmic X-ray background estimation
- ▷ source confusion limit
- ▷ source identification, overlap with HED
- ▷ Fe line spectroscopy
- ▷ anticoincidence
- ▷ pulsar timing studies
- ▷ hard X-ray mission

## ■ specifications

- ▷ field of view  
**12 arcmin**  
**> 7 cm Ø**
- ▷ angular resolution  
**≤ 20 arcsec**  
point spread function  
**< 1.9 mm**
- ▷ energy range  
**0.5 ... 20 keV**
- ▷ energy resolution  
**150 keV @ 6 keV**
- ▷ min. frametime
- ▷ time resolution  
**100 µsec**
- ▷ "transparent"
- ▷ s/c constraints

## ■ LED parameters

- ▷ format  
**8 x 8 cm<sup>2</sup>**  
**128 x 128 pixels**
- ▷ pixel size  
**625 µm □**
- ▷ thin entrance window thickness  
**450 µm**
- ▷ low electronic noise  
**≤ 10 el. ENC**
- ▷ r/o time / row  
**4 µsec**
- ▷ window mode  
**32 pixels**
- ▷ monolithic device
- ▷ high temperature  
**-40 °C**



# LED layout

## ■ collaboration

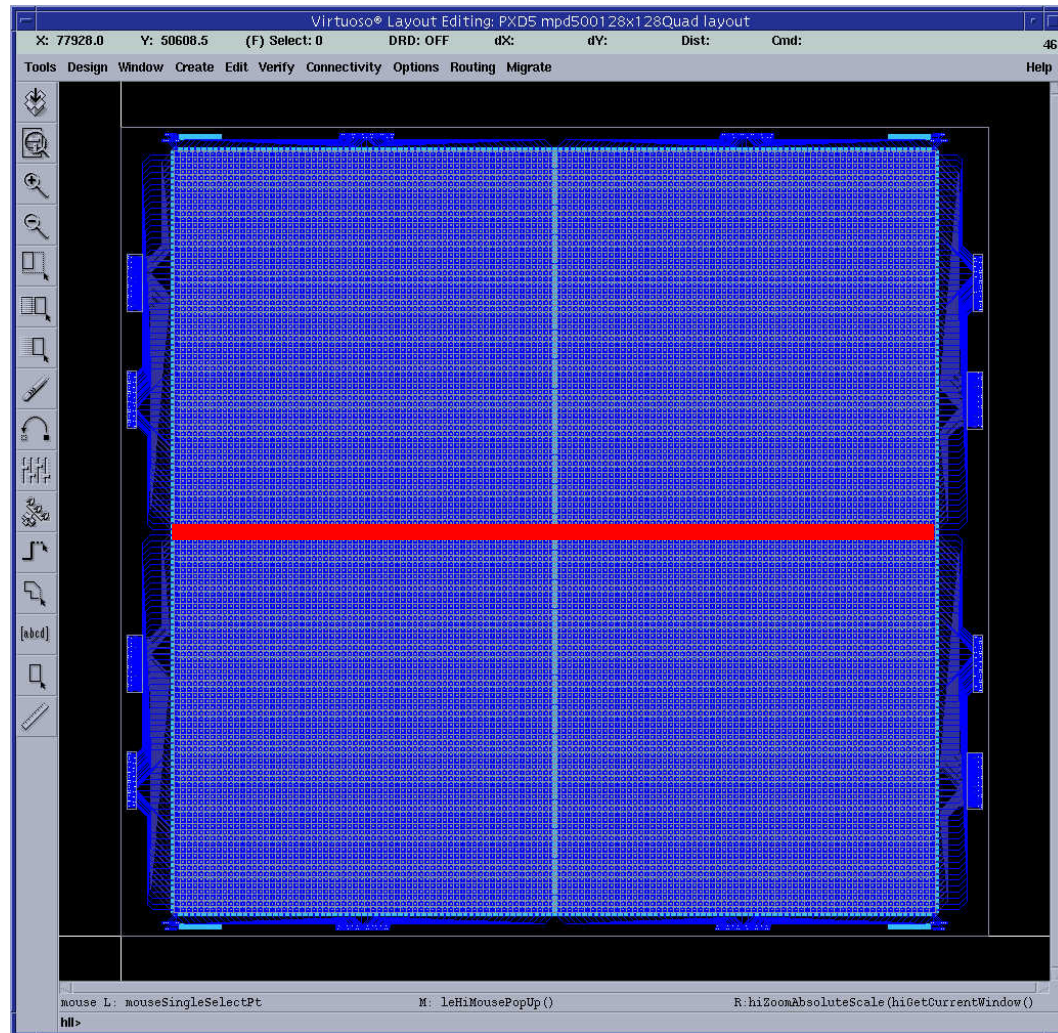
- ▷ HLL/MPE: detector, thermal and mechanical interfaces
- ▷ IAAT: daq system

## ■ Macro Pixel Detector

- ▷ SDD & DEPFET
- ▷ pixel size  $625 \mu\text{m}$   $\square$
- ▷ focal plane format  $128 \times 128$
- ▷ sensitive area  $8 \times 8 \text{ cm}^2$
- ▷ largely redundant quadrants, individual r/o & control

## ■ readout modes

- ▷ full frame  
CCD-like, bi-directional
- ▷ window mode  
selectable window size, no additional hardware



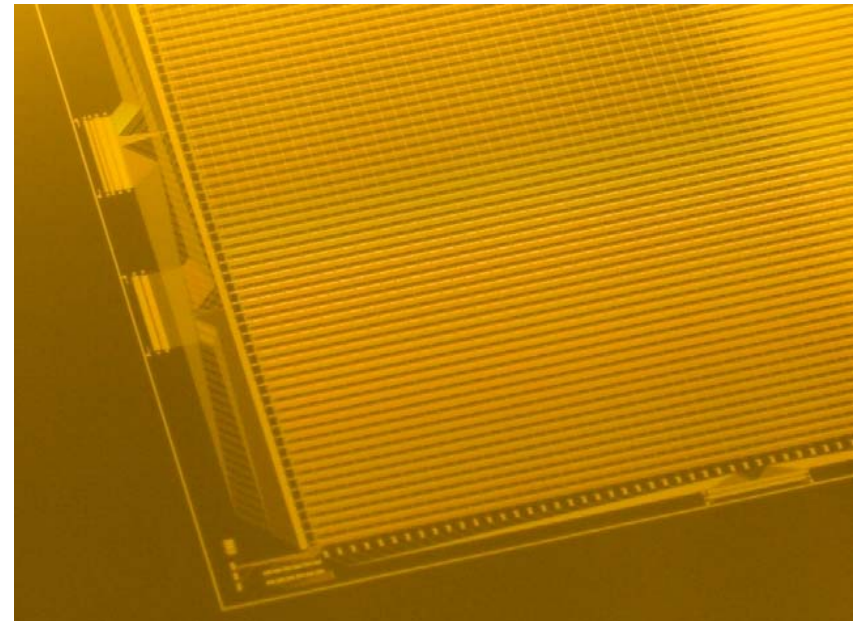
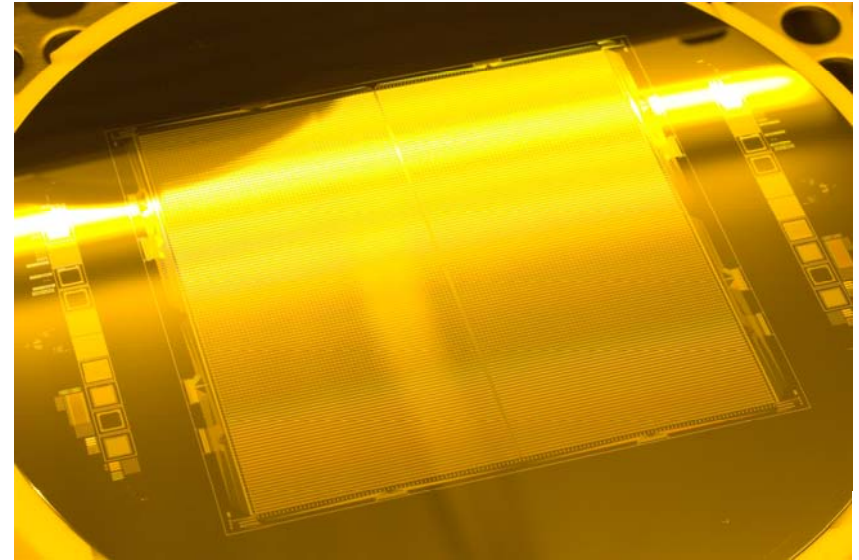


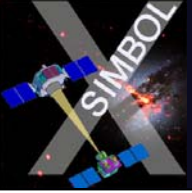


# LED dummy

## ■ SIMBOL-X LED dummy

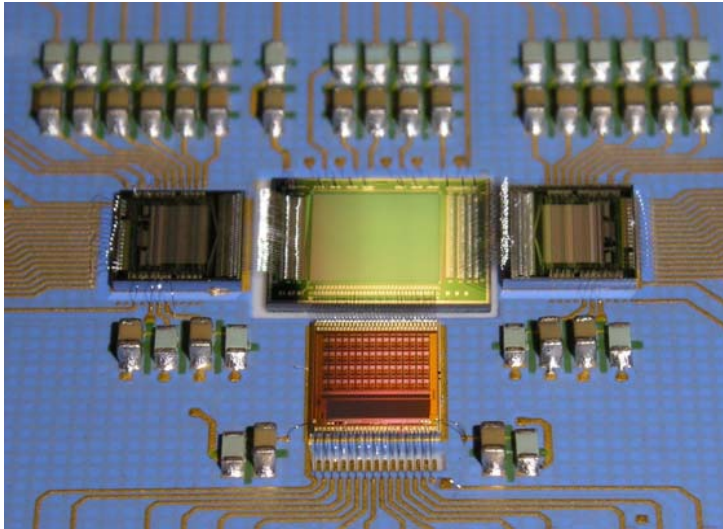
- ▷ design according to the current state of knowledge and technology
- ▷ 128 x 128 pixels (625  $\mu\text{m}$ )  
organised in 4 independent quadrants
- ▷ processing of dummy wafers finished
- ▷ front- and backside metallisation
- ▷ for demonstration
- ▷ structural & thermal model (phase B)





# LED readout and control

## ■ Active Pixel Sensor – XEUS prototype



## ■ 2 x SWITCHER-II control ASIC

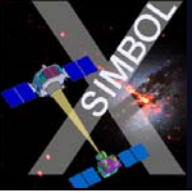
- ▷ 64 channel control chip
- ▷ 2 ports / channel
- ▷ supply of switched voltages
- ▷ high voltage CMOS process  
> 20 V p-p
- ▷ 50 MHz clock

## ■ CAMEX 64 readout chip (baseline)

- ▷ 64 channel amplifier
- ▷ source follower
- ▷ 8-fold CDS filter
- ▷ 64/1 analog multiplexer
- ▷ readout time / row  $\sim 6 \mu\text{sec}$

## ■ VELA readout chip (option)

- ▷ collaboration with PoliMi
- ▷ 4 channel prototype tested
- ▷ 64 channel version in design
- ▷ drain current readout
- ▷ current integration / deintegration filter
- ▷ readout time / row  $< 3 \mu\text{sec}$



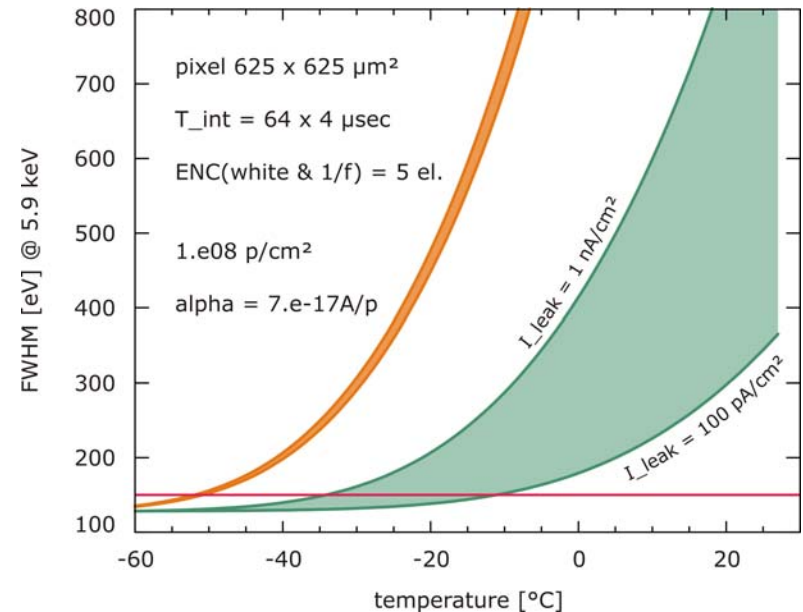
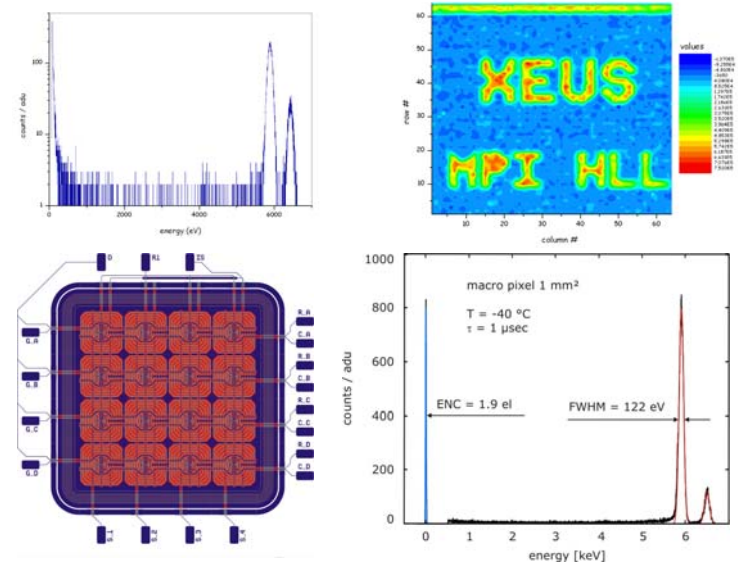
# LED performance

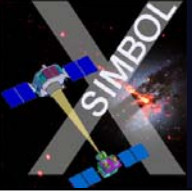
## ■ experience from

- ▷ XEUS WFI 64 x 64 prototypes
  - DEPFET pixels  $75 \times 75 \mu\text{m}^2$
  - readout time / row  $\sim 20 \mu\text{sec}$
  - FWHM @ 6 keV 133 eV
- ▷ Macro Pixel Detector 4 x 4 prototype
  - pixel size  $1 \times 1 \text{mm}^2$
  - integration time  $1 \mu\text{sec}$
  - FWHM @ 6 keV 122 eV

## ■ extrapolated SX energy resolution

- ▷ assumptions
  - RT leakage current  $0.1 \dots 1 \text{ nA/cm}^2$
  - r/o time / row  $4 \mu\text{sec}$
  - serial noise 5 el. r.m.s.
- ▷ radiation damage by solar protons
- ▷ real results soon to come





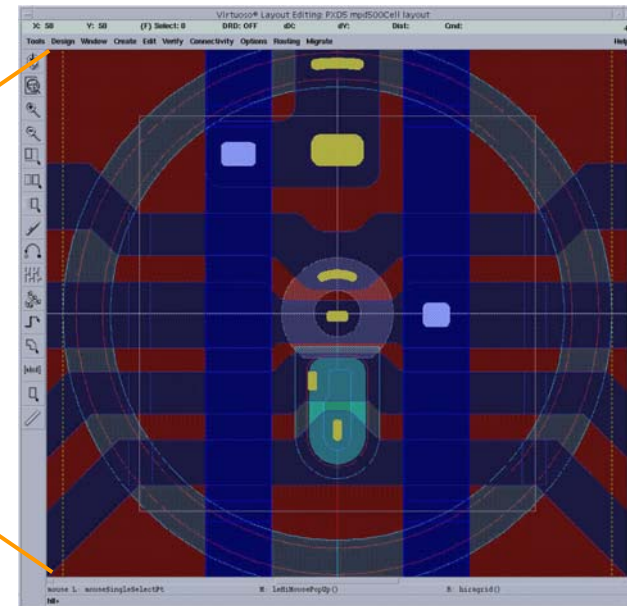
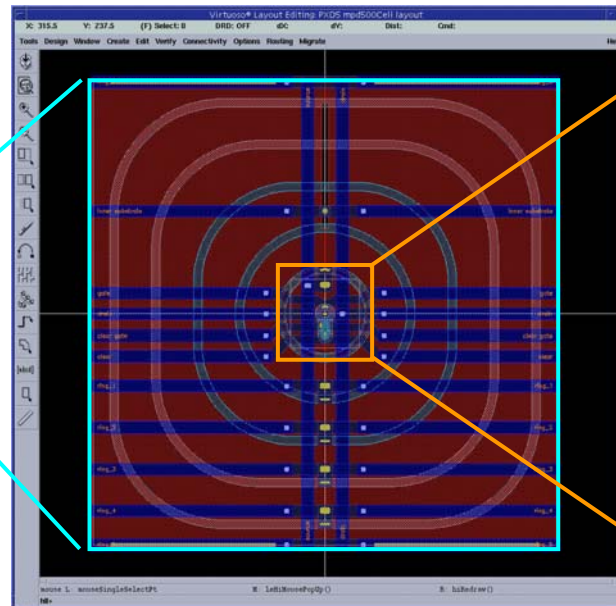
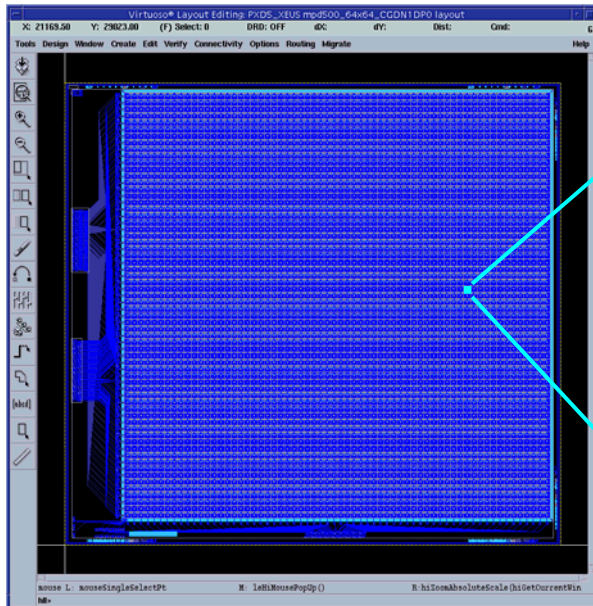
# LED demonstrator

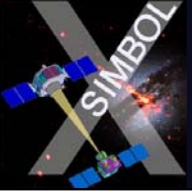
## ■ quadrant prototype

- ▷ science verification module  
phase B, operation with HED
- ▷ 500  $\mu\text{m}$   $\square$  pixels
- ▷ format 64 x 64
- ▷ sensitive area 32 x 32  $\text{mm}^2$

## ■ status

- ▷ 2 chips on PXD5 production
- ▷ difference in DEPFET clear structure
- ▷ 1st Al layer, to be patterned this week
- ▷ available in Jul07





# summary & outlook

- Low Energy Detector

Simbol-X representative detector in summer

- Simbol-X mission

good chance to get into phase B in 2008

- ... if that occurs

flight hardware processing in 2008